Collective Dynamics at RHIC

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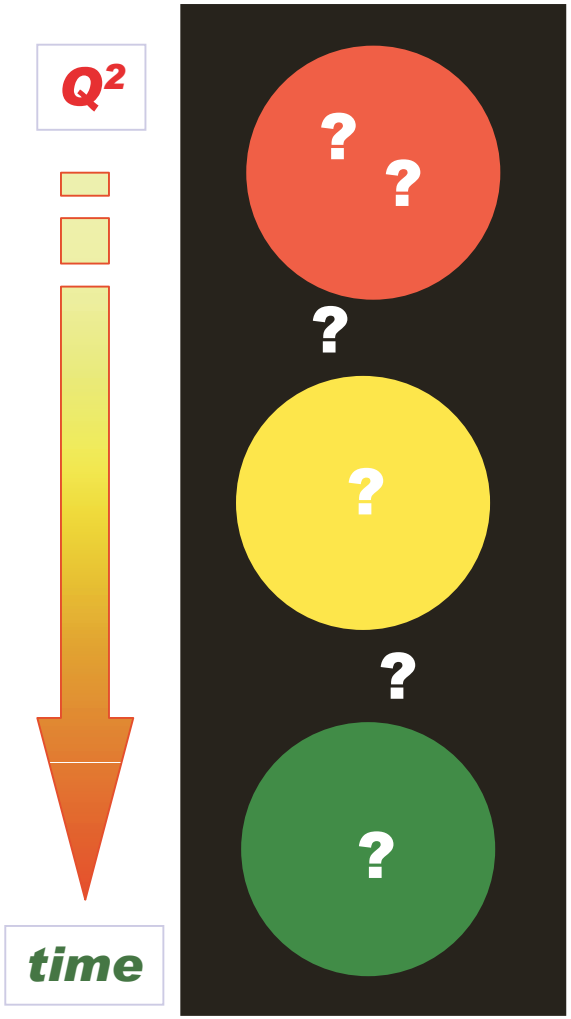
Collective Dynamics at RHIC

1) What do we want to know?
   - QGP: partonic collectivity
2) What we know
   - Results from SPS and RHIC-I
3) How to get there?
   - Hadron spectra and v_2, especially
     K_S, ϕ, Λ, Ξ, Ω, J/ψ, ...

4) Protons near beam rapidity

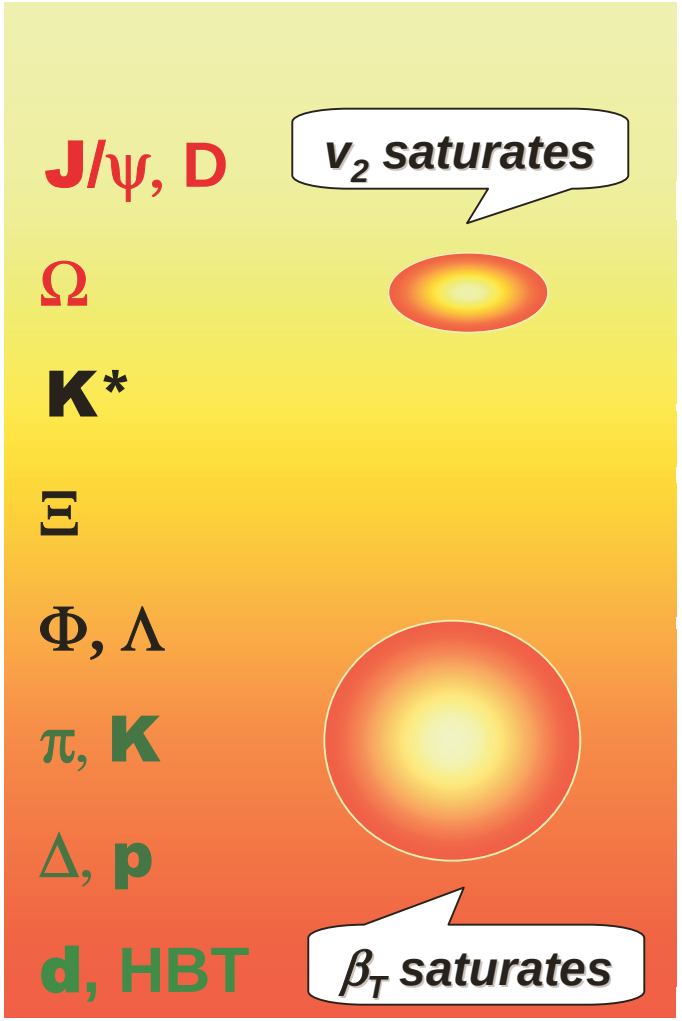
Introduction



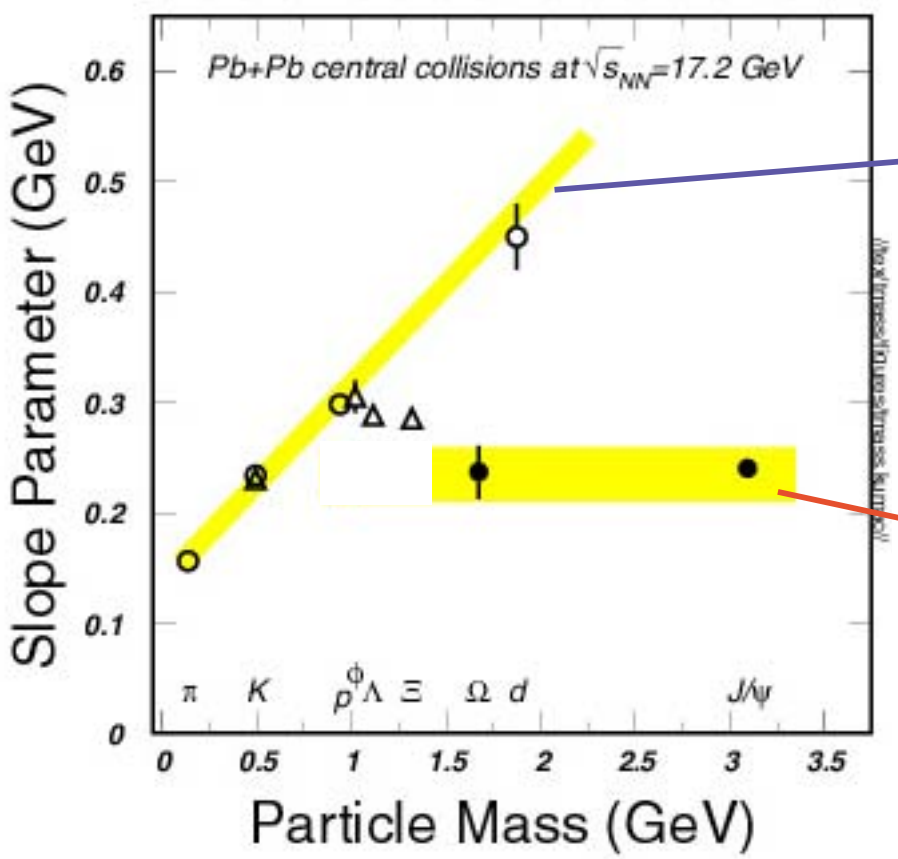
1) Initial Condition
- *baryon transfer*
- *E_T production*
- *partons dof*

2) System Evolves
- *parton/hadron expansion*

3) Bulk Freeze-out
- *hadrons dof*
- *interactions stop*



T vs. Mass Plot (SPS)



Interaction with hadronic gas:

- Large X-section limit:
  pions, kaons, protons

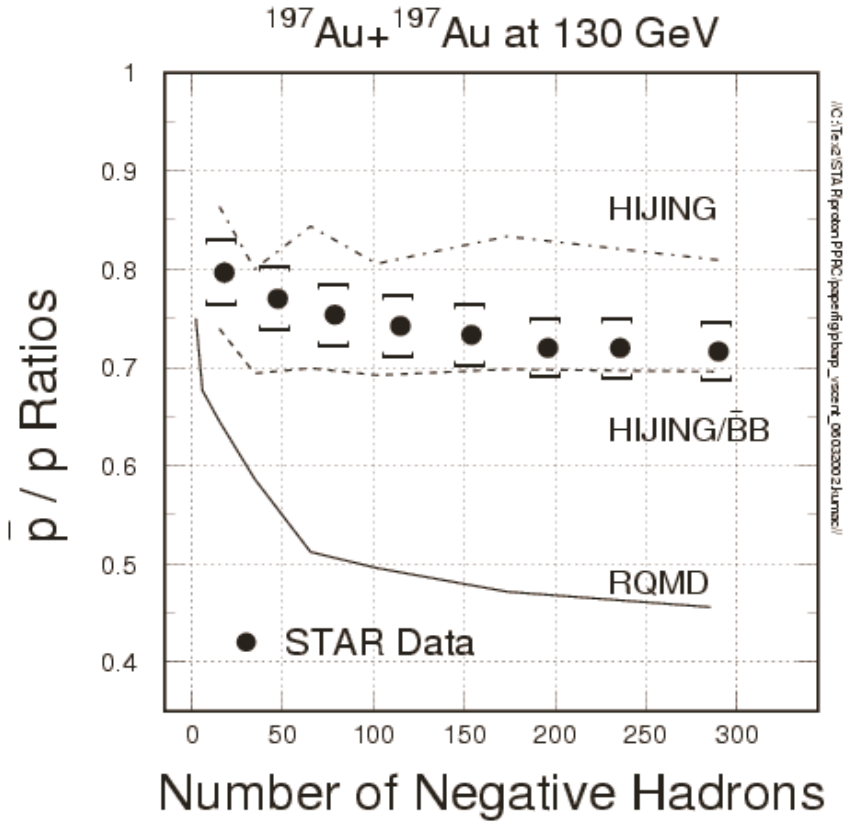
$$T_{fo} = T_{th} + mass * \bar{\beta}^2$$

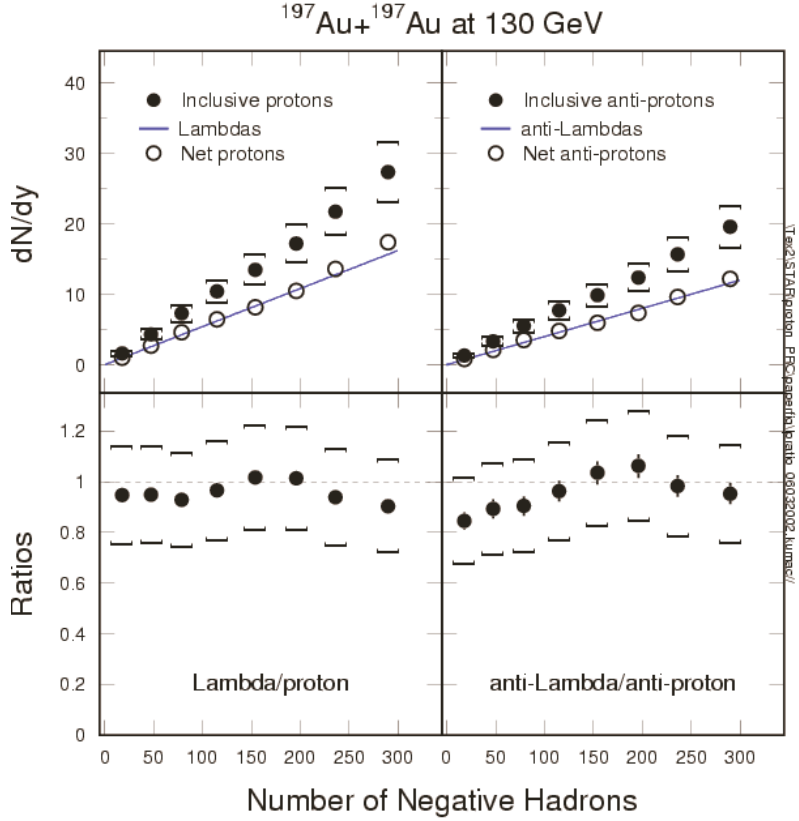
- Small X-section limit:
  Ω, J/ψ

$$\varphi_i \propto exp\left[- \pi \frac{m_i^2 + p_t^2}{\kappa} \right]$$

sensitive to hadronization!

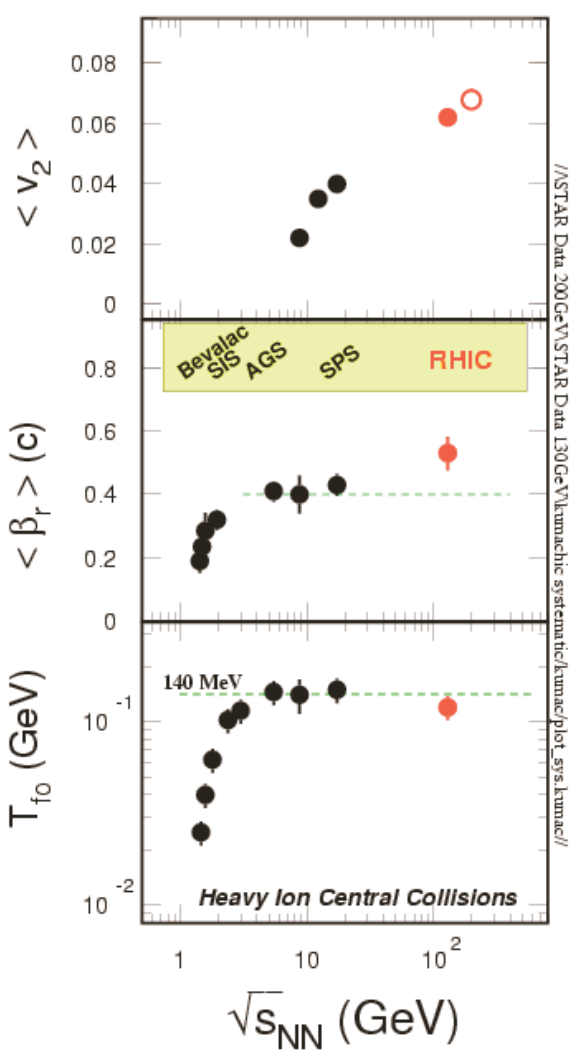
What We Know - RHIC I

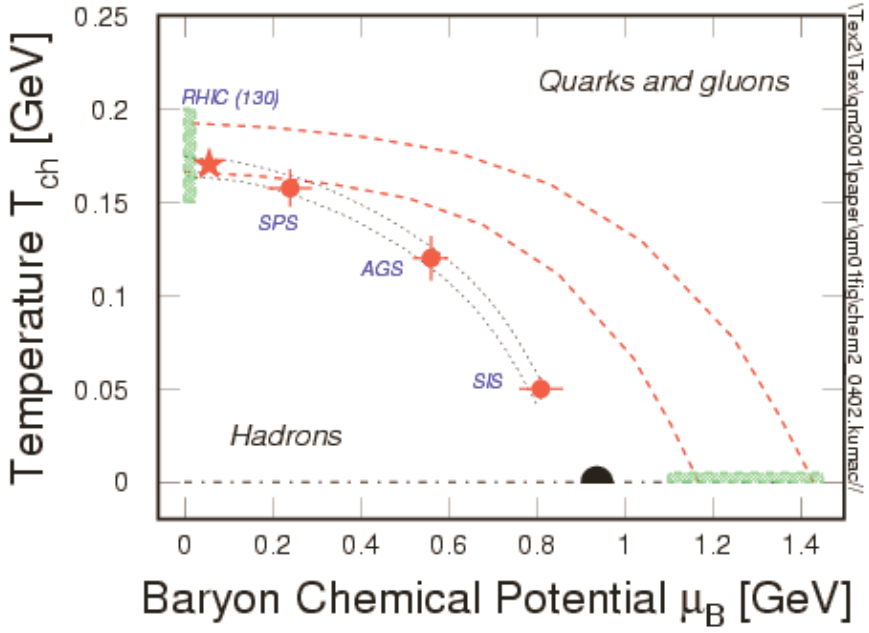




1) At RHIC pbar/p, lbar/pbar ~ constant vs. centrality
2) At AGS, factor ~100 / SPS factor ~ 2 variation
   => re-scatterings at hadronic stage reduced at RHIC !

Beam Energy Systematic

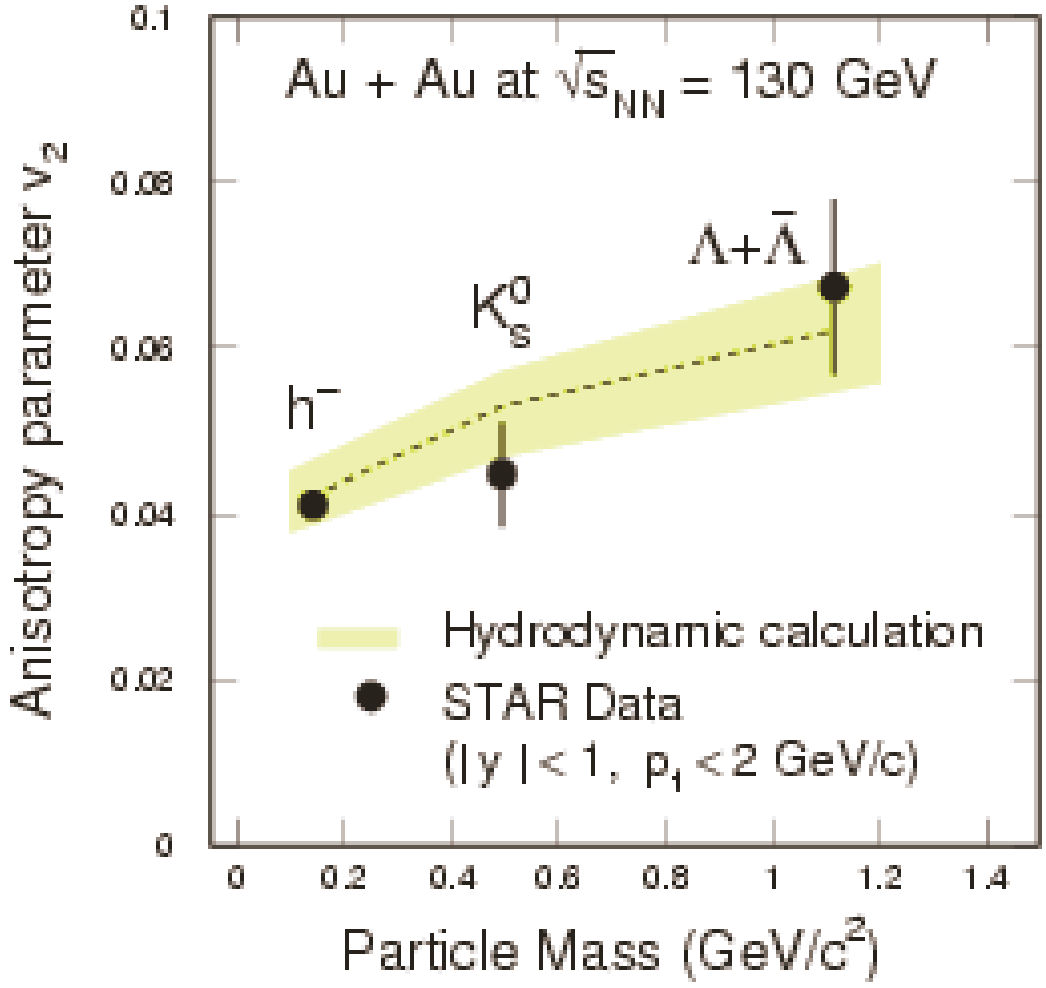




1) Smaller baryon chemical potential
μ_B = 45 MeV with T_{ch} = 170 MeV
⇒ ***Approaching net-baryon free !***

2) Stronger transverse flow, β_T= 0.55(c)
⇒ ***More explosive expansion !***

What We Know - RHIC I

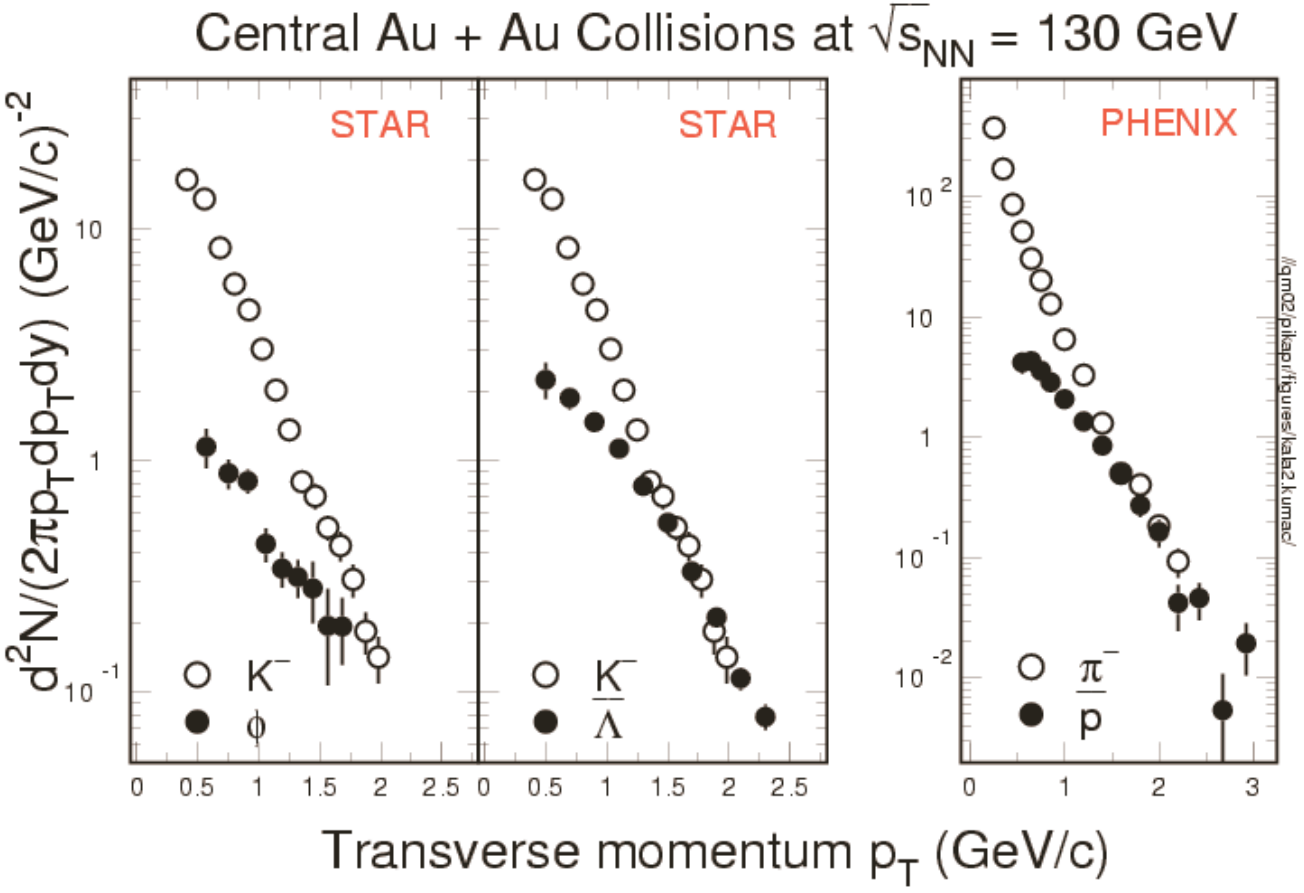


1) Integrated v2 increase with particle mass ;
2) Hydro model results are consistent with data. But 'QGP' EOS used in hydro calculation!

Does v_2 signal parton flow?

STAR sub. to PRL, May 2002

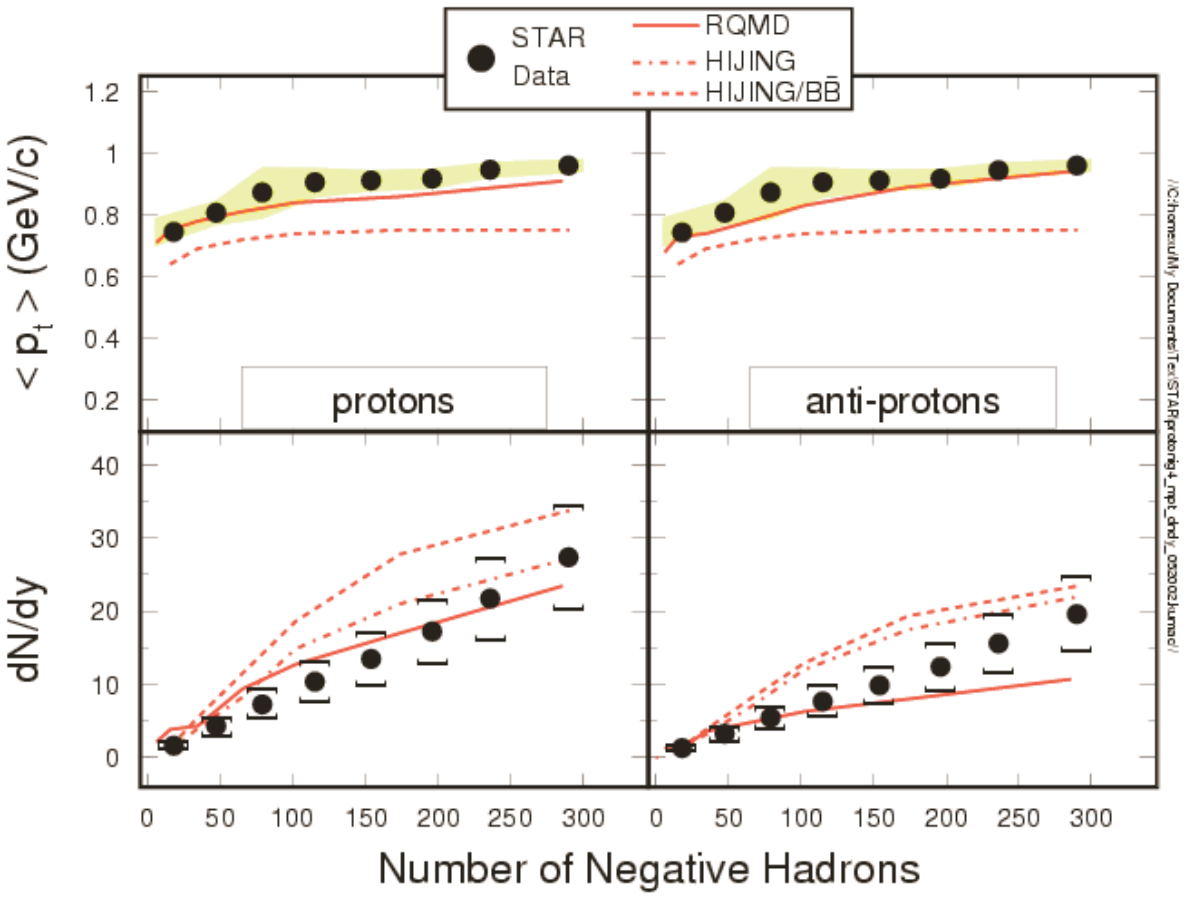
Transverse collective flow



Heavier mass particles show stronger collective flow effect !

PHENIX: PRL**88** 242301(2002) / STAR: ϕ PRC**65**, 041901(02); Λ and Kaon: sub. to PRL

What We Know - RHIC I



- increase in $\langle p_t \rangle$ vs centrality → radial flow
- RQMD describes transverse motion reasonably well → hadronic re-scattering
- RQMD underestimates pbar yield due to large annihilation X-section → re-scattering at earlier stage?

What We Know - RHIC I

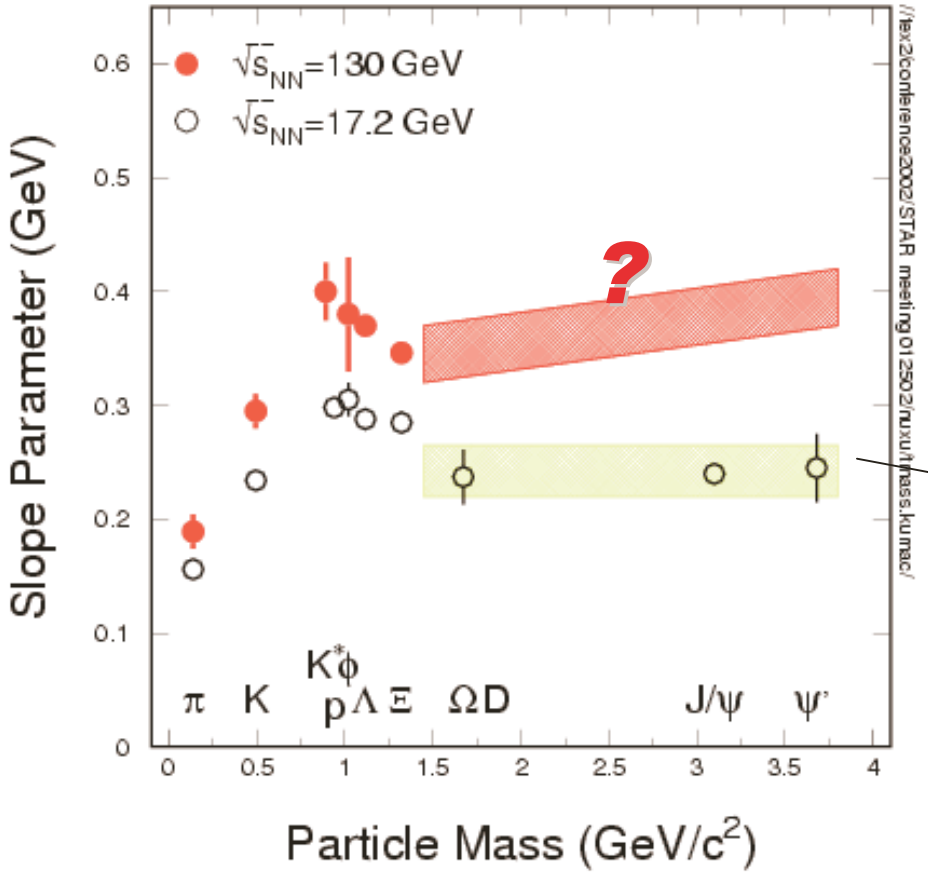
RQMD – re-scattering at hadronic stage
spectra, not yields, not ratios
HIJING – no re-scattering at hadronic stage
centrality dependence pbar/p, lbar/pbar ratios
not spectra

Copious scattering needed !
But not at the hadron stage !
Patonic flow?!

To ‘see’ it directly, spectra and v_2, especially

K_S ϕ Λ Ξ Ω J/ψ ...

Slope parameters vs. mass



$$\varphi_i \propto exp\left[- \pi \frac{m_i^2 + p_t^2}{\kappa} \right]$$

$$\kappa = \kappa_0 * \sqrt{n} = \kappa_0 * \rho_{gluon}$$

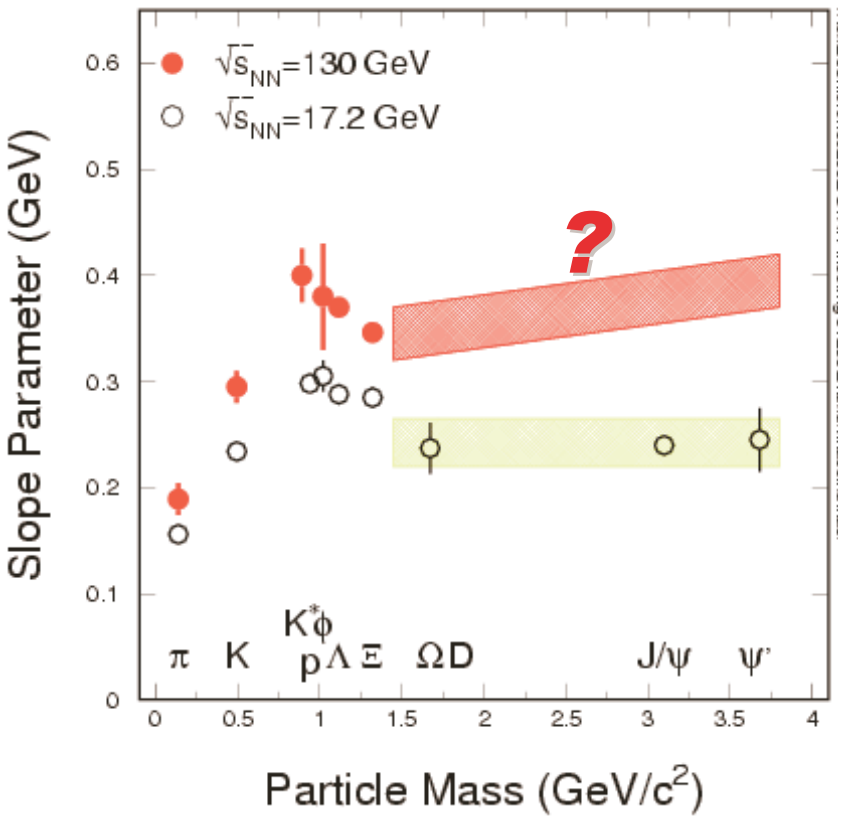
- Small X-section limit: Ω, J/ψ

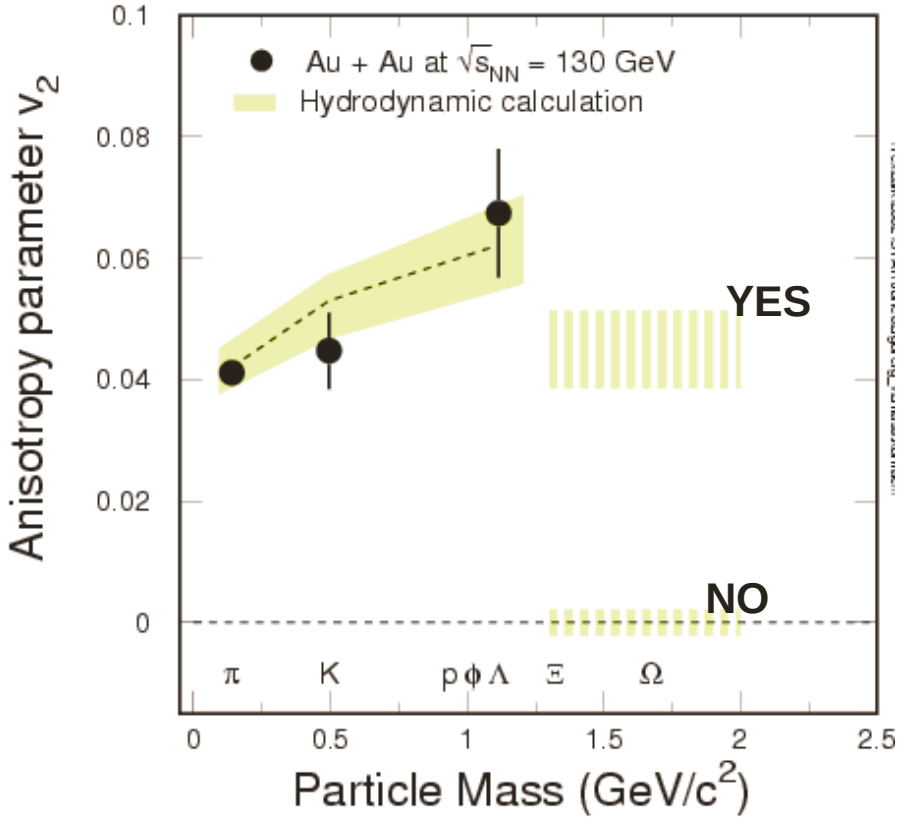
sensitive to collectivity at parton level?

- At high energy, high gluon density leads to parton flow

100 M Au+Au mb events for v_2 of Ω, Ξ, ….

Partonic Flow at RHIC?





'... that is the question.'

(100M Au+Au events)

How to get there?

Discovery patonic collectivity – ‘QGP’

Diagnostic bulk properties of ‘QGP’

Important:

- Scan collision geometry ***b***
- Scan colliding size ***A***
- Scan collision energy ***E***

Upgrade issues

1) Faster Data Acquisition

2) TOF barrel

3) SVT: increase V^0 efficiency by a factor of 2-7

Lots of heavy ion beam !